

federal scientific

Federal Scientific Corporation
A subsidiary of Thompson-Starrett Company, Inc.
615 West 131st Street, New York, N. Y. 10027

Mr. T. Nelson
Systems Consultant
Schooleys Mountain, New Jersey 07870

HIRE CLASS MAIL

HIRE CLASS MAIL

**Here's the
information**

- a unique scientific and manufacturing organization
- pioneers in signal analysis and sophisticated data reduction
- manufacturers of the Ubiquitous[®] real time signal analysis equipment

federal scientific

a subsidiary of Thompson-Stratton Corporation, Inc.

TECHNICAL LITERATURE

Federal Scientific Corporation
615 West 131st St., New York, N.Y., 10027

federal scientific

Areas of special competence

Instruments for Real-Time Signal Analysis

Federal Scientific Corporation has been concerned with advanced signal-processing techniques since its formation in 1957. Initial research and investigation into real-time spectrum-analysis methods led to the invention of the Coherent Memory Filter (U.S. Patent No. 3,013,209). Numerous Coherent Memory Filters were incorporated in advanced radar systems and are on continuous 24-hour operating schedules.

The Ubiquitous® Spectrum Analyzer, designed in 1965 and produced in quantity since, represents a breakthrough in instrumentation for quantitative spectrum analysis of signals with frequency resolution (bandwidth) ranging from a fraction of a Hz to the kHz range. Many variations of the Ubiquitous® Analyzer have been designed and shipped for such diverse applications as:

- underwater acoustic analysis
- vibration and noise analysis
- radar signal analysis
- speech processing

Equipments include percentage-bandwidth units, multi-channel systems, digital input and output units, and power-spectral-density systems. The high-speed digital time-compression techniques have also been applied to real-time correlation analysis. The list of customers of this equipment includes the Navy, Air Force, Army, NASA, and other government agencies, as well as major industrial corporations, such as aircraft and aircraft-engine manufacturers. Numerous units are in use throughout the world, providing reliable operation day in and day out.

Signal Processing and Computer Utilization

Over the past five years, FSC has operated a spectrum-analysis facility in support of its speech research. The spectra of about 10,000 words have been computer-processed to determine invariant spectral characteristics for the purpose of mechanized word recognition. FSC has interfaced its spectrum analyzers with IBM-729 tape equipment. Recently, a Ubiquitous® Spectrum Analyzer was interfaced with a DDP-116 and an IBM-1800 computer for on-line speech analysis.

FSC has an IBM-1800 on its premises. About 25 percent of its technical staff members are conversant with FORTRAN IV. Other computers such as the IBM-7094 and the CDC-1604 are used off-premises.

Advanced Radar Systems

FSC has made significant and fundamental contri-

butions to the radar art, especially in the fields of pulse-compression and coherent radar, with particular emphasis on, and experience in, systems employing FM-CW techniques and those achieving a high degree of target discrimination at long range.

Defense-System Analysis and Associated Development

The staff includes recognized experts in the analysis and development of systems for defense against airborne and ballistic targets. FSC has been a major subcontractor of Bell Telephone Laboratories on the NIKE-X and NIKE-Zeus programs.

Acoustics and Automated Pattern Recognition

Broad, high-level staff experience equips FSC to undertake research and development in theoretical and experimental acoustics and speech research, including techniques that may be usefully applied to intelligence and surveillance problems. Contracts for Rome Air Development Center, for example, have elicited commendation for an unusual demonstration of computer recognition of a vocabulary of spoken words.

Scientific-Data Analysis and Statistical Data-Processing

The staff has extensive experience in the large-scale statistical processing of data derived from such diverse sources as ballistic-missile trajectories, radar cross-section patterns, reentry wakes, speech, and other phenomena. They bring to such problems knowledge of, and facility with, the latest techniques of information theory, error analysis, and computer programming.

Electro-Optics and Space Navigation

FSC has engaged in theoretical studies, equipment development, and test programs in the field of automatic star recognition by the passive analysis of radiated optical spectra. These techniques can also be applied to attitude control and mid-course guidance.

Radar Simulation

FSC has realistically simulated the random, as well as the systematic, behavior of a scanning, pulse-type radar. It is prepared to develop similar equipment for simulation of pulse-Doppler systems and MTI radars, and for the statistically valid simulation of radar "clutter."

The company

Federal Scientific Corporation (FSC) celebrated its tenth anniversary in 1967. The company has a staff of over 100 (February 1968), and occupies 25,000 sq. ft. of space on Manhattan's West Side, within walking distance of Columbia University and the College of the City of New York.

Federal Scientific Corporation's management is composed primarily of engineers who firmly believe in providing an environment in which ambitious engineers will continue to grow professionally. The company's electrical-engineering staff is composed of top-notch men; most are members of Eta Kappa Nu or

Tau Beta Pi; almost all have M.S. degrees or are working toward advanced degrees. In the design of equipment, new techniques are the order of the day.

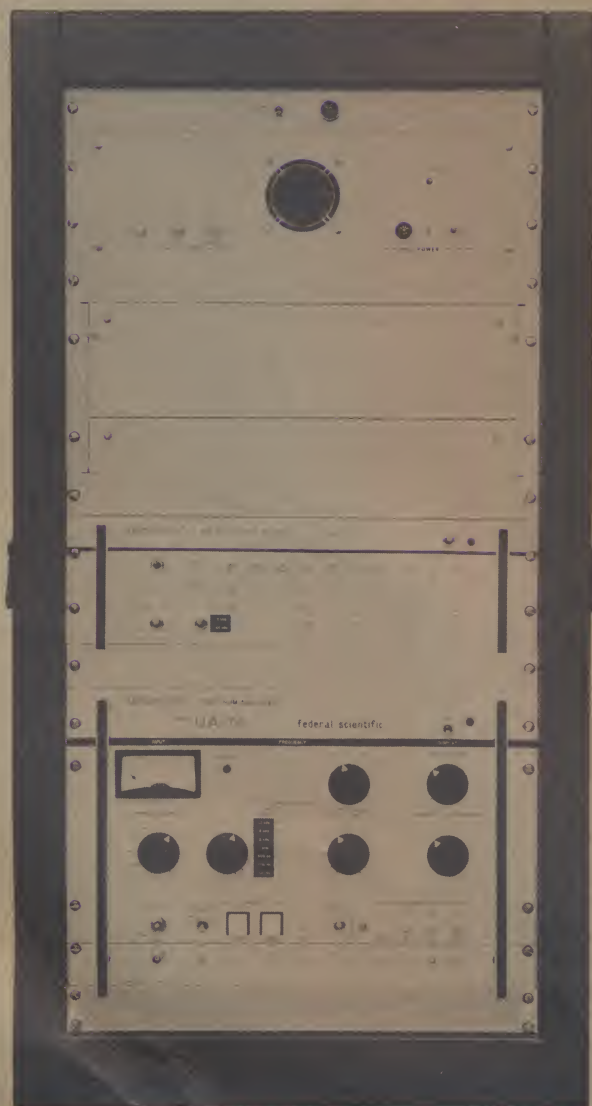
In the manufacturing area, FSC has assembled a staff of men who are particularly experienced in the assembly and testing of integrated circuits. Its manufacturing manager is an expert in assembly techniques for miniature electronic equipment. FSC is embarked on a course of product design and manufacture which exploits the most recent component technology and which frequently benefits from company-sponsored training in new techniques.

federal scientific

a subsidiary of Thompson-Starrett Company, Inc.

TECHNICAL LITERATURE

Federal Scientific Corporation
615 West 131st St., New York, N.Y. 10027
Tel. 212-286-4400



BUSINESS REPLY MAIL

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

FIRST CLASS
PERMIT NO. 36933
NEW YORK, N. Y.

POSTAGE WILL BE PAID BY

FEDERAL SCIENTIFIC CORPORATION

615 W. 131 STREET
NEW YORK, NEW YORK 10027



PLEASE SEND ME MORE INFORMATION ON:

- | | |
|---|---|
| ☐ UBIQUITOUS Spectrum Analyzer (10 kHz Coverage) | ☐ Power Spectral Density System Model PSD-7 |
| ☐ Speech Analysis Opt. 28 | ☐ Cross-Power Spectral Density and System Transfer Function System |
| ☐ Wide Coverage UBIQUITOUS Spectrum Analyzer (100 kHz Coverage Model UA-8) | ☐ Transient and Shock Spectrum Analyzers |
| ☐ Correlation Analyzer Model UCA-7 | |

NOTES:

MAIL TO:

Name _____
Title _____ Dept. _____
Company _____
Address _____
City _____ State _____ Zip _____
☐ Add my name to your M/L please. ☐ Remove my name from your M/L.

I EXPECT TO HAVE A REQUIREMENT

- ☐ immediately ☐ next 90 days ☐ during next year ☐ academic interest
☐ please have your representative call me at _____

MY APPLICATION IS

- ☐ Vibration ☐ Noise ☐ Speech ☐ Radar ☐ Medical
☐ Underwater sound ☐ ASW ☐ Shock ☐ other (specify) _____

1-1-68

FEDERAL SCIENTIFIC CORPORATION

SUBSIDIARY OF THE THOMPSON-STARRETT COMPANY, INC.

615 WEST 131st STREET • NEW YORK, N.Y. 10027 • (212) 286-4400

Date 10/4/68

In reply please refer

to X1132A-10

Mr. T. Nelson
Systems Consultant
Schooleys Mountain, New Jersey 07870

Dear Sir:

In reply to your recent request, we are enclosing the following:

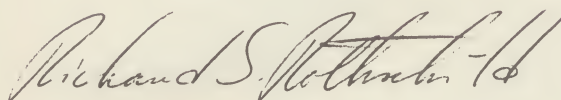
Literature pertaining to Ubiquitous® Spectrum Analysis and
Speech Analysis, and recording.

In order to serve you better, we would appreciate your filling out and
returning the enclosed card.

Should you need further information, please contact our local representative
or call me directly.

Thank you for your interest. We look forward to working with you on your
application for our products.

Sincerely yours,



Richard S. Rothschild
Vice-President Marketing

cc: Representative:

Burlingame Associates
510 South Fulton Avenue
Mt. Vernon New York
Tel: 914- MO 4-7530

Federal Scientific Corporation's

SHORT-TERM LEASE-PURCHASE PLAN

Federal Scientific Corporation will build and deliver any current catalog equipment under the following terms:

1. Delivery: The normal delivery quoted at the time of the lease contract will apply
2. Minimum leasing period: The minimum lease period is four months for the Model UA-6 Ubiquitous Spectrum Analyzer and six months for all other equipment. The lease period starts at the time of receipt of the equipment at the customer's plant, or at the conclusion of final checkout by an FSC representative at the customer's plant (if the latter is required in lieu of the normal checkout with the customer's representative present at FSC prior to shipment).
3. Rental: 10% of the list price of the equipment per month.
4. Service: Standard installation support, checkout aid, instruction manuals, and warranty service terms apply.
5. Purchase: At any time during the lease period, FSC will accept an order for the purchase of the equipment being leased and will apply 90% of the amount already paid under the lease toward the purchase price.

If an order is placed within three months after the end of the lease period

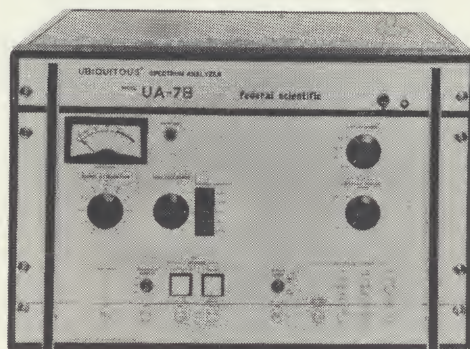
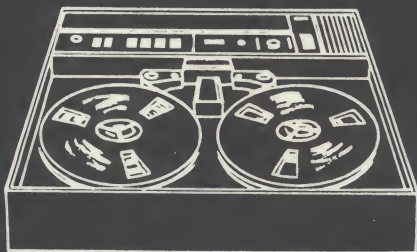
- (a) to buy equipment that had been leased, 80% of the amount paid-in will be applied toward the purchase price, except in the case of a Model UA-6 Ubiquitous[®] Spectrum Analyzer, in which 90% will be applied.
- (b) to buy equipment other than that which had been leased, 60% of the amount paid in will be applied toward the purchase price of the new equipment.

FEDERAL SCIENTIFIC CORPORATION /615 WEST 131ST STREET, NEW YORK, N.Y. 10027/(212) AUDUBON 6-4400

5-1-68

FSC-L-353/100

Inputs.



Our REAL-TIME Spectrum Analyzers are truly UBIQUITOUS®

... because there's a model for every use.

BASIC UA-6: Spectrum analysis in ranges of 0-10 Hz to 0-20 kHz with bandwidths of .02 Hz to 40 Hz (origin of range located to 1 mHz with options)

EXTENDED RANGE UA-8: Wide coverage spectrum analysis with ranges to 0-100 kHz

SPEECH ANALYZER UA-7/28: Spectrum analysis to 10 kHz with variable bandwidth for optimum processing by allowing tradeoff of frequency resolution for time resolution

DIGITAL PROCESSOR UA-7/51: Direct digital input and output for operation in all-digital systems

SHOCK ANALYZER UA-7/37: Shock spectrum analysis with capture of transients in non-destructive memory

ENGINE SIGNATURE UA-7/14: Engine order normalization for rotating machine signatures independent of RPM

PERCENTAGE BANDWIDTH UA-7/64: Percentage bandwidth analysis in addition to constant bandwidth in any of 10 octave ranges with percentage variable from 0.4% to 3.2%

CORRELATION UCA-7: Simultaneous correlation and spectrum analysis

NOISE OR VIBRATION PSD-7: Real time power spectral density without tape loops producing 2 years of PSD in one day

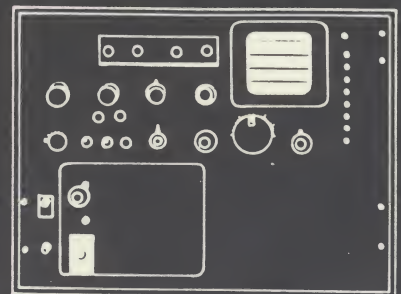
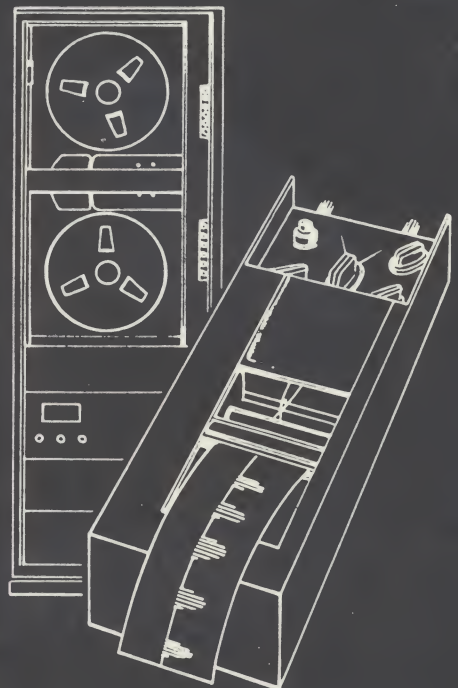
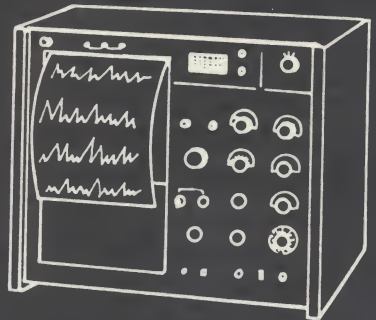
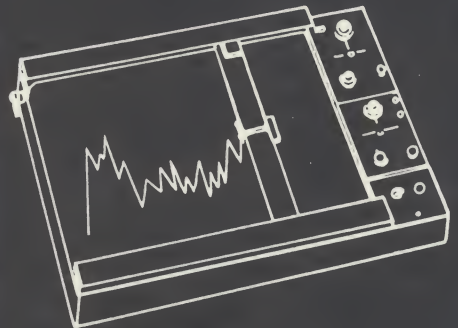
UNIVERSAL PROCESSOR UPS-7: Includes real time correlation, cross-power spectral density and transfer function analysis to 10 kHz

Federal Scientific Corporation, a subsidiary of T S T Industries, Inc., 615 West 131st Street, New York, N. Y. 10027. (212) 286-4400.

federal scientific

Originators of the Ubiquitous® Spectrum Analyzer

Outputs.



'Ten-kHz' spectrum analyzer can pick signals from noise

Federal Scientific Corp., 615 W. 131st St., New York, N.Y. 10027. Phone (212) 286-4400. P&A: Model UA-7B, \$25,850; 90 days.

The Ubiquitous spectrum analyzer gets its name from its ability to derive a spectrum based on simultaneous observation of a whole ensemble of samples of a time-varying signal. In effect, it duplicates the characteristics of a set of narrowband contiguous filters. For the 0-to-10-kHz range, each simulated filter has a bandwidth of 20 Hz.

The operation of the spectrum analyzer is based on the use of a recirculating delay-line memory. The samples are "speeded up" in the memory, and thus the output waveform, as illustrated in the diagram, is an accelerated version of the original waveform. In the continuous mode, new samples from the input are sequentially fed into the memory, replacing previously stored samples. In the hold mode, to observe transients or selected segments of a waveform, the most recent 1500 samples are continuously circulated and their spectrum displayed. No matter how long it took to accumulate the samples, they are time-compressed to 100 μ s in the memory.

The accelerated waveform, when restored to analog form, is hetero-

dyned with a stepped local oscillator. Because the signal has been shifted to a higher frequency, a fairly wideband crystal (10 kHz) filter in the MHz range gives results equivalent to those obtainable with a narrowband filter in the signal's actual lower frequency band. The local-oscillator stepping is synchronized with the memory recirculation period. Thus, each time the 1500 samples in the memory loop cycle once, the local oscillator is advanced 10 kHz. This action is repeated until the entire spectrum has been scanned.

Note in the block diagram that a shaping function is used to amplitude-modulate the local-oscillator signal. In the heterodyner, this function is multiplied with the signal from the D/A converter. The result is that the filter output appears as if it had passed through a filter whose characteristic is a product of the crystal filter's actual impulse response and the shaping function. Thus a simple output filter can be used, and its characteristics modified by the shaping function chosen.

A triplet function is used in the Ubiquitous analyzer. The resulting spectral response has a broader main lobe than some other alternate functions would produce, but it rolls off more sharply. The triplet is expressed as $\omega(t) = [\exp$

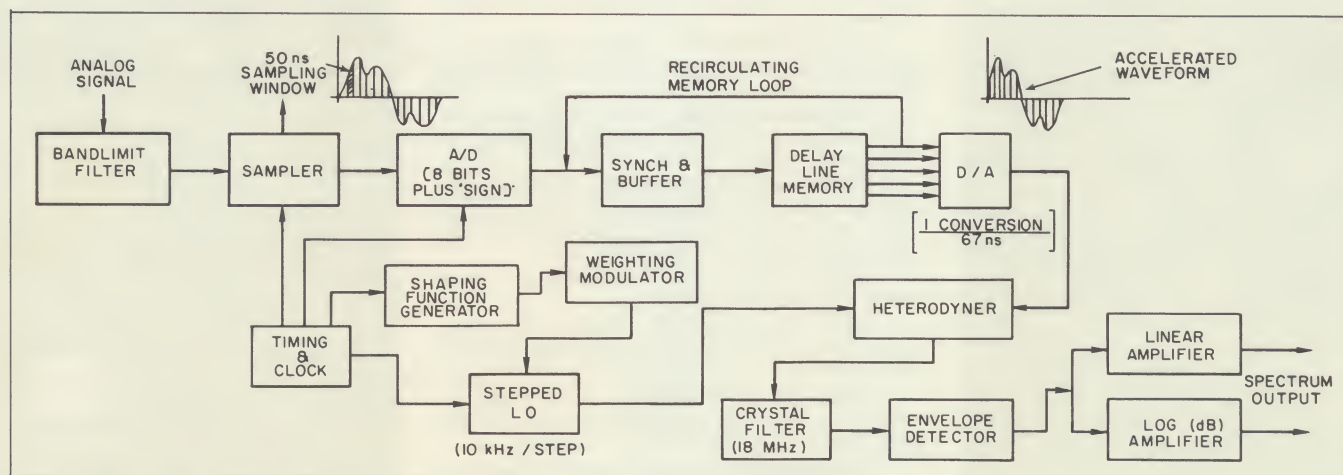
$(-\pi t/P)] [\sin^2(\pi t)/P]$ where $t \leq P/2$. The reason for the use of the triplet is that it can resolve closely spaced spectral components of greater difference in amplitude than alternate functions would achieve.

This "speed-up" type analyzer allows the user to trade off between analysis frequency range and bandwidth of the simulated filter bank by simply turning a knob. For the 0-to-5-kHz range, for example, 10-Hz filters are synthesized. Also, spectrum display periods can be selected. Twenty analyses per second provide a flickerless oscilloscope display, while longer periods can be chosen for recorder or plotter outputs.

Although the accuracy does not match that possible with fully digital Fast-Fourier Transform analyzers (see "The FFT computer; Designers' 'missing link,'" ED 25, Dec. 6, 1967, pp. 25-30), it operates at considerably higher speed than any commercial FFT machine. Real-time processing is provided with 1-dB amplitude accuracy and with 50-dB dynamic range. However, only power spectra, without phase information, are produced.

Applications include radar and sonar signal processing, vibration and noise analysis, speech studies, interferograms and medical diagnostics. The analyzer can be used to perform single- or dual-channel Fourier analyses, cross-spectrum or transfer-function analysis, and auto- and cross-correlations.

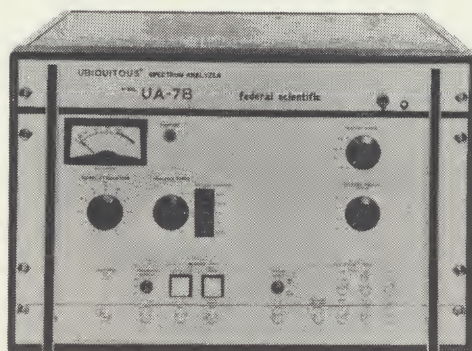
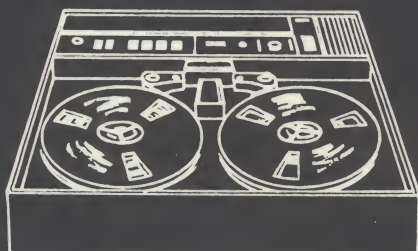
CIRCLE NO. 290



Speed-up-type spectrum analyzer combines digital and analog techniques. Low frequency signals are shifted to

higher frequencies for spectral analyses. Text explains operation of the instrument.

Inputs.



Our REAL-TIME Spectrum Analyzers are truly UBIQUITOUS®

... because there's a model for every use.

BASIC UA-6: Spectrum analysis in ranges of 0-10 Hz to 0-20 kHz with bandwidths of .02 Hz to 40 Hz (origin of range located to 1 mHz with options)

EXTENDED RANGE UA-8: Wide coverage spectrum analysis with ranges to 0-100 kHz

SPEECH ANALYZER UA-7/28: Spectrum analysis to 10 kHz with variable bandwidth for optimum processing by allowing tradeoff of frequency resolution for time resolution

DIGITAL PROCESSOR UA-7/51: Direct digital input and output for operation in all-digital systems

SHOCK ANALYZER UA-7/37: Shock spectrum analysis with capture of transients in non-destructive memory

ENGINE SIGNATURE UA-7/14: Engine order normalization for rotating machine signatures independent of RPM

PERCENTAGE BANDWIDTH UA-7/64: Percentage bandwidth analysis in addition to constant bandwidth in any of 10 octave ranges with percentage variable from 0.4% to 3.2%

CORRELATION UCA-7: Simultaneous correlation and spectrum analysis

NOISE OR VIBRATION PSD-7: Real time power spectral density without tape loops producing 2 years of PSD in one day

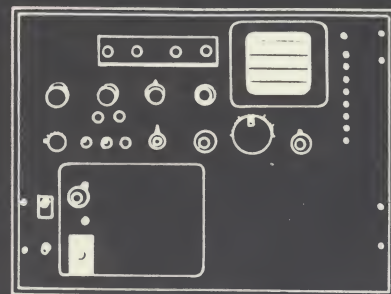
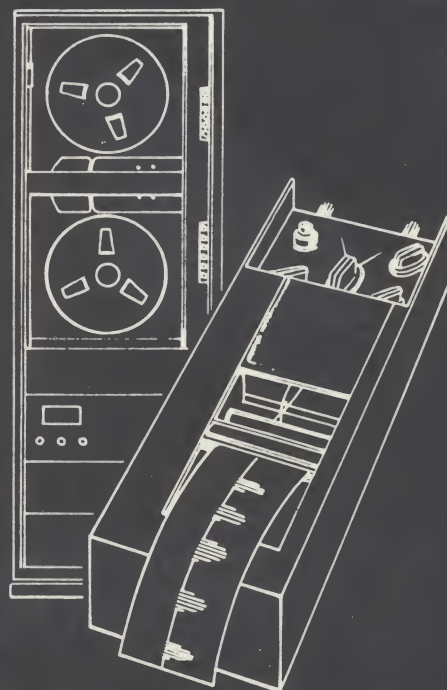
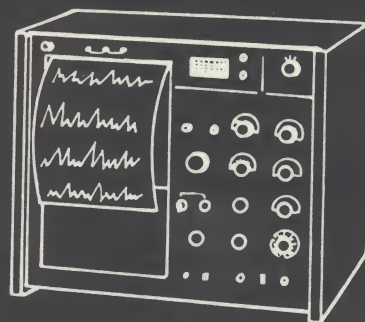
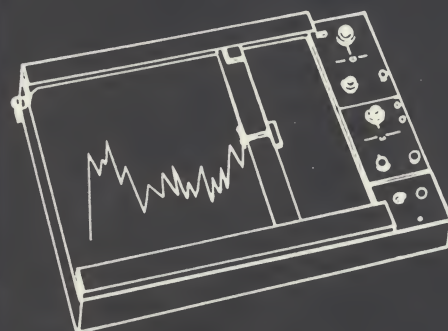
UNIVERSAL PROCESSOR UPS-7: Includes real time correlation, cross-power spectral density and transfer function analysis to 10 kHz

Federal Scientific Corporation, a subsidiary of T S T Industries, Inc., 615 West 131st Street, New York, N. Y. 10027. (212) 286-4400.

federal scientific

Originators of the Ubiquitous® Spectrum Analyzer

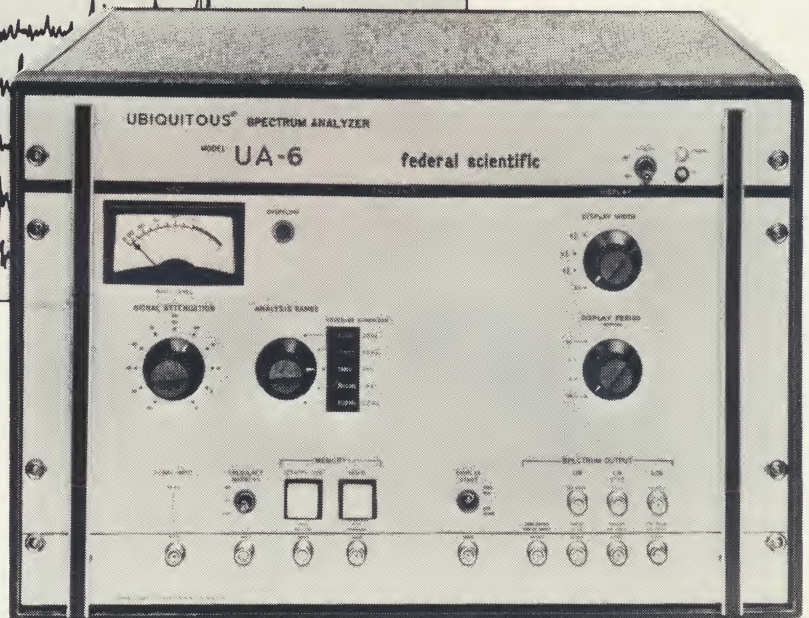
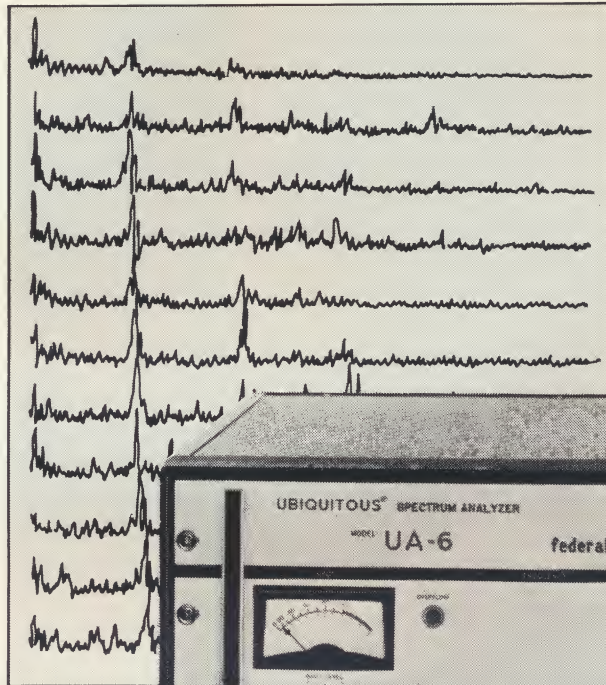
Outputs.



Son of Ubiquitous®

Ubiq™

Now a **REAL-TIME SPECTRUM ANALYZER** that combines the most popular features of the famous **UBIQUITOUS®** series in one basic model with a new top range of 20 kHz. Quantity production makes possible the first-time low price of under \$20,000.



The Model UA-6, the UBIQ™, is a new addition to our line of analyzers employing digital time-compression techniques to perform 500 point spectrum analysis in real time. It is the latest in Federal Scientific's family of Ubiquitous® Spectrum Analyzers, those reliable units which have become an industry standard.

Over 50 Ubiquitous® Spectrum Analyzers are being used throughout the free world for processing underwater acoustic signals, radar doppler, speech, and noise and vibration data. The most common features asked for by users over the past three years have now been combined in this new basic model, the UA-6, whose quantity production allows exceptionally low pricing. Like all Ubiquitous Analyzers the UA-6 operates much faster than most digital computers using fast Fourier transforms, but is considerably smaller and less expensive.

Its new features include:

8 frequency ranges from 10 Hz to 20,000 Hz with filter bandwidths of 0.02 Hz to 40 Hz (optional bandshifting up to 1 mHz)

Improved flexibility including tracking of single fre-

quency components

Built-in calibration and test signals for quantitative display, recording or X-Y plotting (optional digitized spectrum output)

All signal conditioning and waveform and timing pulses for display and recording are in one self-contained unit

Greater usable dynamic range for power spectral density analysis

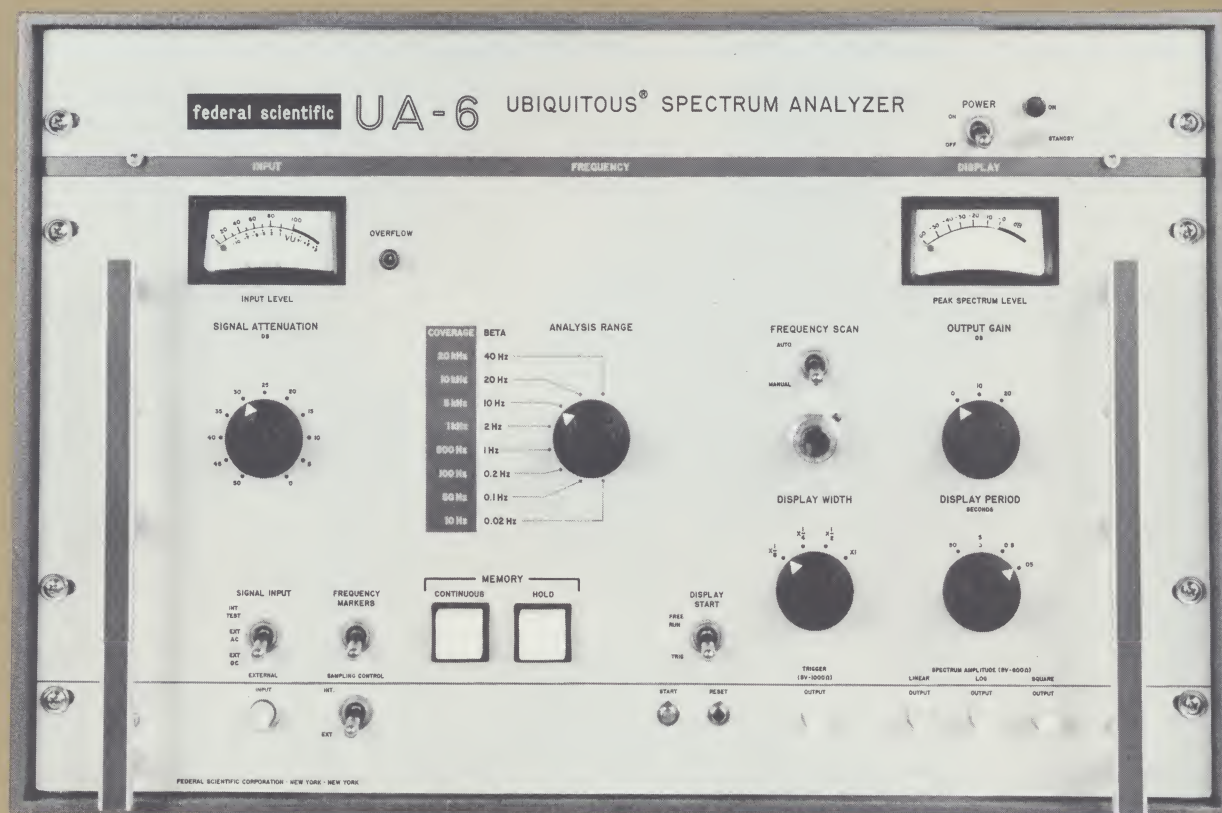
The UA-7 series Ubiquitous® Spectrum Analyzers have also been improved for special applications requiring percentage bandwidth analysis, correlation, cross-power spectral density and system transfer function analysis, multi-channel processing, digital computer interface, engine order normalization, or 100 kHz extended coverage.

Write us for detailed specifications on the UA-6 UBIQ Spectrum Analyzer.

Federal Scientific Corporation, a subsidiary of TST Industries, Inc., 615 West 131st Street, New York, N.Y. 10027. Tel: 212-286-4400.

federal scientific

Originators of the Ubiquitous® Spectrum Analyzer



Model UA-6 Ubiquitous[®] Spectrum Analyzer the Ubiquitous[™]

A REAL-TIME spectrum analyzer that combines all the most popular features of the well-known Ubiquitous[®] series in one standardized model in order to make available the economy of quantity production

APPLICATIONS:

underwater sound classification
noise and vibration analysis,
radar signal processing
spectrum surveillance
speech study
transient capture
rotating machine signatures

GROWTH POTENTIAL:

UA-6 Analyzers are expandable to multi-channel spectrum analysis, cross-spectrum analysis, transfer-function analysis, auto and cross-correlation, Cepstrum analysis, shock-spectrum analysis. (Write for Bulletin No. 610)

FEATURES:

- real-time 500-point analysis for on-line monitoring or optimum processing of tape data
- 8 ranges from 0-10 Hz to 0-20 kHz with bandwidths of 0.02 Hz to 40 Hz respectively (optional bandshifting to 1 MHz) plus choice of any other intermediate range down to dc through external control
- greater usable dynamic range for power spectral density analysis
- built-in calibration for amplitude and frequency axes, including manual frequency scanning
- waveform and timing signals available to match fast or slow display and recording devices (optional digital output with computer formatting) plus automatic sweep-rate control for X-Y plotting
- external sampling permits compensation for tape wow and flutter plus automatic frequency tracking for engine order normalization

federal scientific

The Model UA-6 . . . the Ubiq™ . . . is a new addition to Federal Scientific's line of Ubiquitous® Spectrum Analyzers, of which over 50 units are now in operation throughout the free world. Ubiquitous® Analyzers are hybrid instruments employing high-speed, digital time-compression to compute the amplitudes of 500 Fourier components in real time.

The input signal is continuously digitized and stored in a simple, reliable delay-line memory. The digital representation of the signal is read out of memory many times faster than it is read in and the resultant time-compressed signal is converted back to analog form. This time-compressed, frequency-expanded replica of the original signal is continuously analyzed in analog form with a wide filter sweeping rapidly, thus taking advantage of the simplicity and speed of analog spectrum analysis.

Like all Ubiquitous® Analyzers, the UA-6 operates much faster than standard all-digital processors using fast Fourier transforms, but is considerably smaller and less expensive. The UA-6 produces spectra 500 times faster than traditional swept-frequency analyzers which require cumbersome tape loops. This means that two years (500 working days) of analysis can be performed in one day!

The UA-6 produces high-resolution, 500-point spectra with a wide choice of front-panel controlled frequency ranges and bandwidths. An optional Range Translation Unit allows bandshifting of the top 5 ranges to any frequency up to 1 MHz by means of heterodyning with an external stable oscillator.

The UA-6 is a stable, accurate instrument, designed for quantitative analysis over a wide dynamic range with fine frequency resolution. Built-in test signals allow amplitude and frequency calibration without additional equipment. External sampling synchronization isolates the spectrum from input tape speed variations or allows display of the spectra of rotating machines in terms of engine order.

EXPERIENCE:

Federal Scientific, the originators of the Ubiquitous® Spectrum Analyzer, developed the first commercial high-speed, digital time-compression unit in 1966. Over 50 units are now in use giving reliable service in applications such as detection and classification of underwater signals, processing of radar data, analysis of noise and vibration signals, and characterization of speech. The long list of customers includes numerous Government facilities as well as aircraft and jet engine manufacturers. A continuing program of improvement emphasizes increased performance coupled with reliability. Ubiquitous® Spectrum Analyzers employ proven integrated circuit design and inherently simple delay line memories. All plug-in construction provides easy access to all circuitry for service. Military-type components are used wherever practical.

APPLICATIONS:

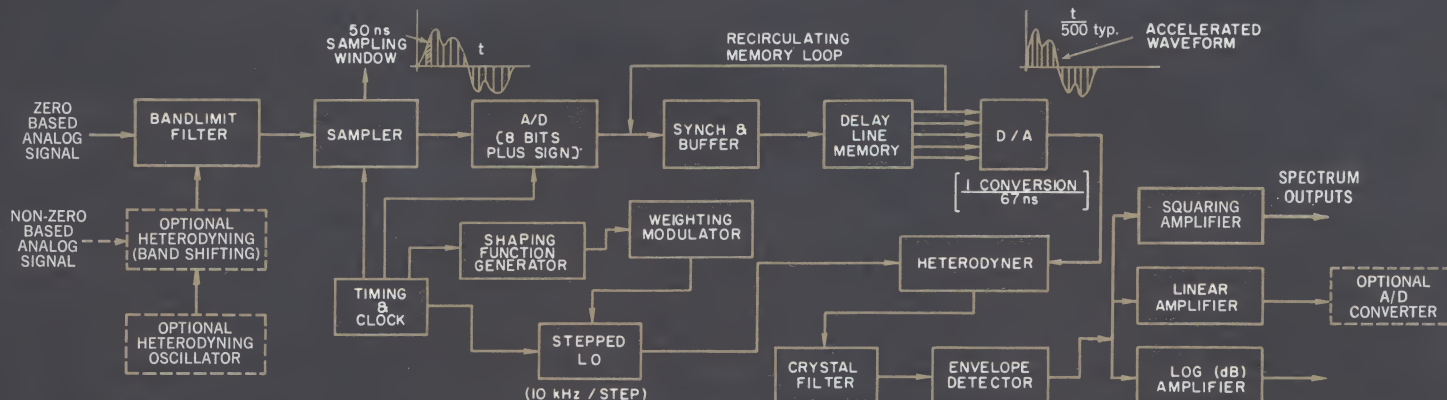
Noise and Vibration — The UA-6 includes extended frequency coverage to 20 kHz eliminating the need for bandshifting in many applications. An output gain control allows full utilization of the instrument's dynamic range in the spectrum analysis of broadband signals. The addition of an Optional Digital Averager (see Option 129's) provides real-time power spectral density plots without the need for tape loops. Test runs can be monitored on-line to verify the quality of the data recorded and to provide alarm before excessive vibration causes damage. For rotating machines such as jet engines, the operator can choose to display the frequency axis in terms of engine rotational speed. Thus, spectral components related to the engine rotation remain fixed in location as the engine changes speed, and engine signatures are more easily read.

Radar and Speech — The real-time capabilities of the UA-6 make possible time history or 3-D recordings of spectra. The dynamics of spoken words, the Doppler shifts in radar data, or the changing sounds of jet aircraft flying overhead can be traced as a function of time. In addition, a manual frequency scan control allows a single frequency component to be tracked and plotted as a function of time. By use of the Display Width control, one frequency band can be analyzed with different bandwidths and spectrum rates for optimum tradeoff of time resolution and frequency resolution, e.g. 5 kHz can be analyzed with 40 Hz, 20 Hz, or 10 Hz bandwidths with spectrum rates of 80, 40, or 20 per second respectively.

Computer Compatibility — Output spectrum format and timing signals allow the addition of optional spectrum digitizing for direct interface with digital computers or recording on digital magnetic tape. Federal Scientific has had extensive experience in operating, programming, and formatting digital computers and is in a unique position to provide special interface equipment. Ubiquitous® Spectrum Analyzers have already been interfaced with IBM-729 tape units, IBM-1800 and DDP-116 computers, and I/O devices for the IBM-360 series.

Transients — If the digital memory used in the UA-6 is commanded to hold, short duration signals may be captured and the spectra recorded on devices as slow as X-Y plotters. Eight different memory lengths from 25 msec to 50 seconds can be selected to match the transient and provide optimum processing. Optional automatic triggering allows the transient itself to initiate the hold operation.

Underwater Acoustics — Time histories of spectra can be displayed and recorded on-line or from tape data either as amplitude or intensity modulated spectra. Bandwidths are selectable from 0.02 to 40 Hz to optimize signal-to-noise enhancement. The small size and rugged construction of the UA-6 makes possible field as well as laboratory use.



SPECIFICATIONS (see Bulletin 662A for operating principle)

SIGNAL ANALYZED

Input Level: 1V rms max. for full-scale output without input attenuation.

Input Coupling: Dc or ac (ac coupling is not recommended below 10 Hz).

Input Impedance: 100,000 ohms.

Input Attenuator: Input attenuator is provided for a maximum of 50 dB attenuation in 5 dB steps; ± 0.3 dB accuracy at any setting.

Level Monitors: (a) Continuous indication of level on easily read input and output meters, (b) overflow light indicates if the range of input a-d converter is exceeded.

Presampling Filter: The selectivity of the Presampling Filter provides at least 48 dB rejection of spectral components (due to aliasing effects) outside the frequency band selected.

External Sampling: External signal can be used to control sampling rate to eliminate the spectral distortion caused by speed variations of input tape recorders. Spectra also can be displayed in terms of engine order rather than absolute frequency for signature analysis of rotating machinery. Maximum sampling rate is 59,900 Hz. Selection of sampling rate permits choice of any analysis range intermediate to or below the eight standard ranges. (For example, a sampling frequency of 1.5 Hz will provide an analysis range of 0.5 Hz with a bandwidth of 0.001 Hz.)

TRANSIENT CAPTURE

Memory Control. HOLD and CONTINUOUS Modes are actuated either by front-panel lighted pushbuttons or by external signals; HOLD stores signal that is in memory, CONTINUOUS allows updating of memory with new signals. Remote control of memory requires a pulse +6V into 1000 ohms of 1-10 usec min. width (rear connector). Optional automatic memory trigger derived from transient available.

Memory Monitor: The signal stored in the memory may be monitored; amplitude 0.3V peak-to-peak into 100 ohms, ac coupled (rear connector).

ANALYSIS RANGES AND BANDWIDTHS

RANGE	ANALYSIS RANGE (Hz)	BANDWIDTH OF SYNTHESIZED FILTERS, β (Hz)
A	0 to 20,000	40
B	0 to 10,000	20
C	0 to 5,000	10
D	0 to 1,000	2
E	0 to 500	1
F	0 to 100	0.2
G	0 to 50	0.1
H	0 to 10	0.02

The bandwidth of the Ubiquitous® Analyzer is described as follows:

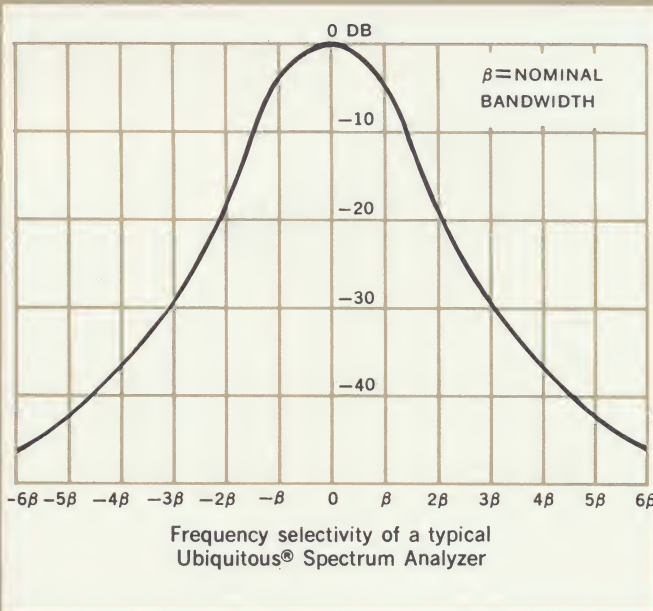
Bandwidth of Synthesized Filters, β , is defined as the reciprocal of the time duration of the input signal, which is in the digital memory. The detailed shape of the frequency selectivity, which is realized by the Ubiquitous® Spectrum Analyzer, is shown below.

The Effective 3-dB Filter Bandwidth is 1.5β . This bandwidth is indicative of the analyzer's ability to resolve two equal-amplitude sinewaves. The filter synthesized has an attenuation asymptote of 18 dB per octave.

The Noise Bandwidth of the synthesized filter is 1.6β . This bandwidth is used to convert (normalize) power spectrum measurements to power spectral density, i.e., power per unit frequency. The noise bandwidth is the bandwidth of a hypothetical rectangular filter, which passes a signal with the same mean square value as the actual filter when the filter input is white Gaussian noise.

Resolution: The spectrum of two equal amplitude sinusoids spaced 2β Hz apart exhibits a 6 dB average valley between its two peaks.

Selectivity: Filter response is -20 dB at a frequency removed from the center frequency by $2.3\beta \pm 15\%$, and -40 dB at $5.2\beta \pm 15\%$.



SPECTRUM CHARACTERISTICS

Spectrum Outputs: Linear, square-law and logarithmic outputs are provided, each with a nominal peak amplitude of +5 volts into 600 ohms, except logarithmic output which is nominally +6 volts for full scale and decreases by 1 volt per 10 dB; base line stability for linear output is 5 mV. Linear step spectrum at rear connector.

Spectrum Amplitude Flatness: Amplitude flatness vs. frequency at the centers of the synthesized filters is ± 1 dB.

Linearity: Input-output linearity for the linear spectrum output is ± 1 dB or $\pm 1/2\%$ of F.S., whichever is greater.

Output Gain: Allows adjustment of levels for maximum usable dynamic range on broadband signals; maximum gain 20 dB.

Dynamic Range: Ratio of minimum detectable signal to full-scale input for any one setting of the input attenuator is 54 dB.

Frequency Linearity: $\pm 0.25\%$ of full analysis range over the entire band of frequencies using built-in frequency markers for calibration.

Broadband Noise: At least 60 dB below full scale.

SPECTRUM DISPLAY

Spectrum Display Periods: Matched to all devices from high repetition rate oscilloscopes to slow X-Y plotters — 0.05, 0.5, 5 and 50 seconds per display, with 500 filters synthesized in .05 second, 5000 in 0.5 second, and 50,000 in all other periods; display rate is reciprocal of display period. Automatic sweep-rate control matches sweep to X-Y plotter speed in order to minimize recording time.

Display Limits: Display width switch terminates display at $1/2$, $1/4$ or $1/8$ of full scale, proportionately decreasing display period and the number of filters synthesized with no change in β . (By use of the display width switch a frequency interval can be analyzed with different bandwidths using segments of different ranges, e.g. $1/4$ of the 20 kHz band, $1/2$ of the 10 kHz band, and all of the 5 kHz band, producing 5 kHz analyzed with β 's of 40, 20, or 10 Hz.)

Display Start: *Internal Start* — Front-panel switch provides free-running displays, externally triggered displays, or manually-initiated single display with front-panel TRIG. pushbutton. (Sweep rests at highest frequency until reset to zero frequency with RESET pushbutton on manual.)

External Start — +6V into 1000 ohms, pulse width of 1-10 usec will initiate the display (rear connector).

Manual Frequency Scan: Switch allows a multi-turn control to select any single frequency component for repeated analysis to simplify calibration or to display the time history of a single frequency component.

Sweep Output: 0 to +2V into 1000 ohms, dc coupled, in time coincidence with the selected spectrum display period (rear connector).

Scope Trigger Output: +6V into 1000 ohms, 2 usec wide pulse; marks the start of each spectrum display period (front panel and rear connector).

Frequency Step Pulse Output: +6V into 1000 ohms; 2 usec wide pulse useful for digitizing the spectrum. One pulse occurs at the start of each frequency step (rear connector).

Unblanking Pulse Output: +6V during sweep, 0 volts during 200 usec flyback (rear connector).

OTHER FEATURES

Calibration and Built-in Test Equipment: Contains a built-in test signal generator which is available for calibration and system check; switch inserts a signal of full spectrum amplitude on all ranges when input attenuator is set at zero dB.

Frequency Markers: Switch introduces 10 equally spaced markers covering each range; provision is made to insert external markers, which typically consist of one or more stable sinewaves at 1 volt rms into 1000 ohms (rear connector).

Control Accessibility: All controls are available on the front panel; all connections available on rear panel and on the front panel where indicated.

Physical Size: 12 $\frac{1}{2}$ inches high by 17 inches wide (standard 19-inch rack panel width) by 22 $\frac{1}{2}$ inches deep.

Power: 117V $\pm 10\%$; 60-405 Hz single phase; 175 watts. (50 Hz operation and other power voltages optional.)

Operating Temperature: +15° C to +35° C.

Storage Temperature: -55° C to +85° C.

Weight: 75 pounds.

OPTIONS AVAILABLE WITH MODEL UA-6 (external to the UA-6 unit)

BANDPASS OPERATION:

Option 30X Range Translation Unit — provides ability to translate Ranges A, B, C, D and E to 1 MHz, using an external oscillator to set the location.

Option 61X-() Origin Step Oscillator — provides discrete frequencies for locating the origin of the ranges provided by the Range Translation Unit.

(Number of frequency steps completes designation.)

SPECTRUM DIGITIZING:

Option 52X. — Digitized spectrum amplitude at 10,000 8-bit binary words per second.

ENGINE ORDER NORMALIZATION:

Option 14ax — Automatic External Low-Pass Filter — provides automatically switched filtering of input signal to prevent aliasing as engine speed varies.

ENSEMBLE AVERAGING:

(see separate specifications)

Option 129B — High-Resolution Digital Averager (512 memory)

Option 129H — High-Resolution Digital Averager (split 1024 memory with data manipulation)

Mod-DO — Display Oscilloscope for 129B or 129H (above)

MOUNTING:

Option 84 — Separate cabinet.

Option 83 — Slides attached for pull-out rack mounting.

POWER:

Option 92a — Operation from 50 Hz line frequency.

Option 92b — Operation from 220 VAC nominal line voltage.

Federal Scientific Corporation
a subsidiary of TST Industries, Inc.
615 West 131st Street, New York, N.Y. 10027
Tel 212-286-4400

federal scientific

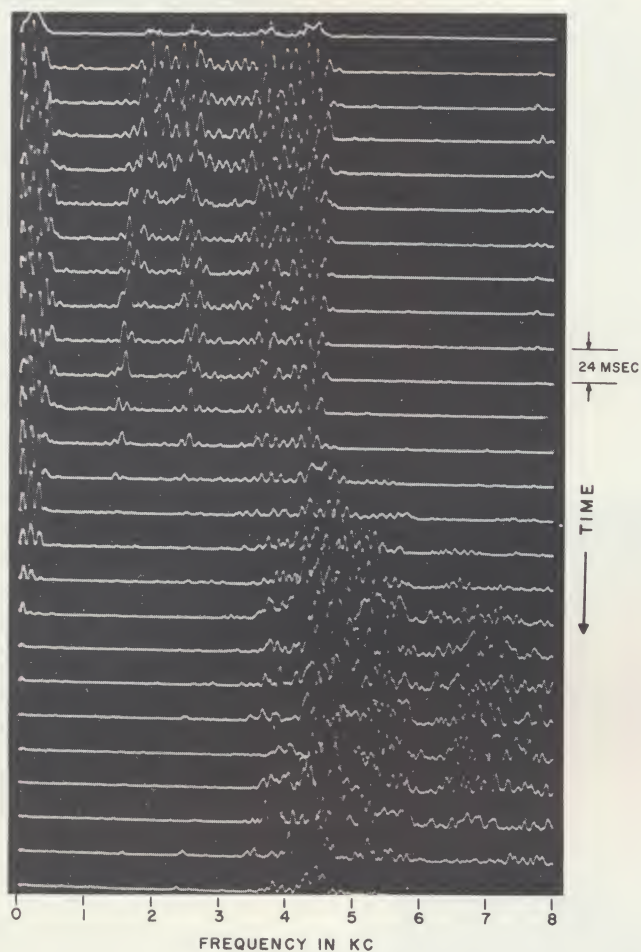
Originators of the Ubiquitous® Spectrum Analyzer

federal scientific

The Ubiquitous[®] Spectrum Analyzer

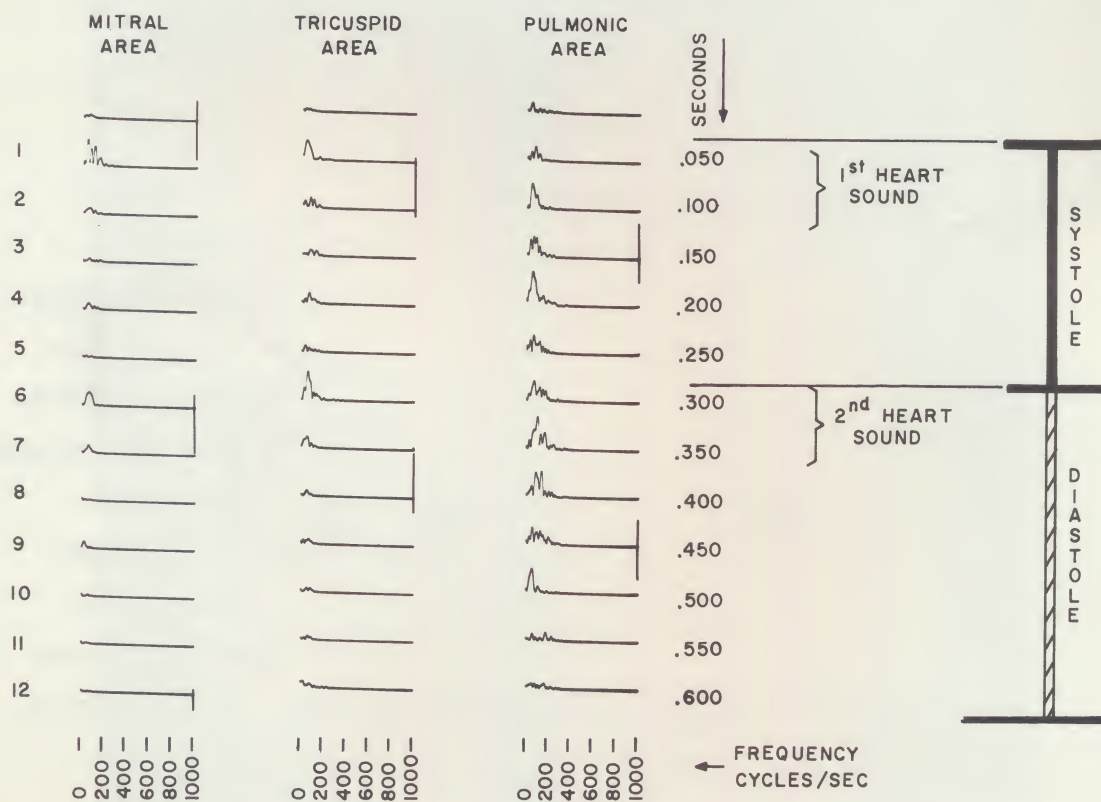


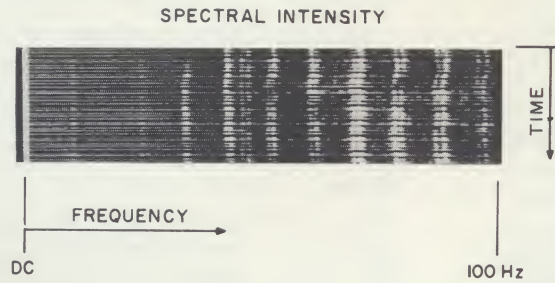
- underwater sound
- acoustic analysis
- vibration and noise
- radar signal processing
- speech study
- shock transients
- interferograms
- medical diagnosis
- MIL environment



Chronological spectrograms of the word "IS." The frequency resolution is 54 Hz, and the time between successive spectrograms is 24 milliseconds. During the initial portion of the word, which is voiced, the downward migration of formant 2 and the constancy of formant 3 and pitch frequency can be noted. During the second half of the word, the termination of voicing and the high-frequency "white" spectrum of the sibilant are seen. The transition from the voiced to sibilant sound transpires in about 50 milliseconds. The entire word is pronounced in about 0.6 second.

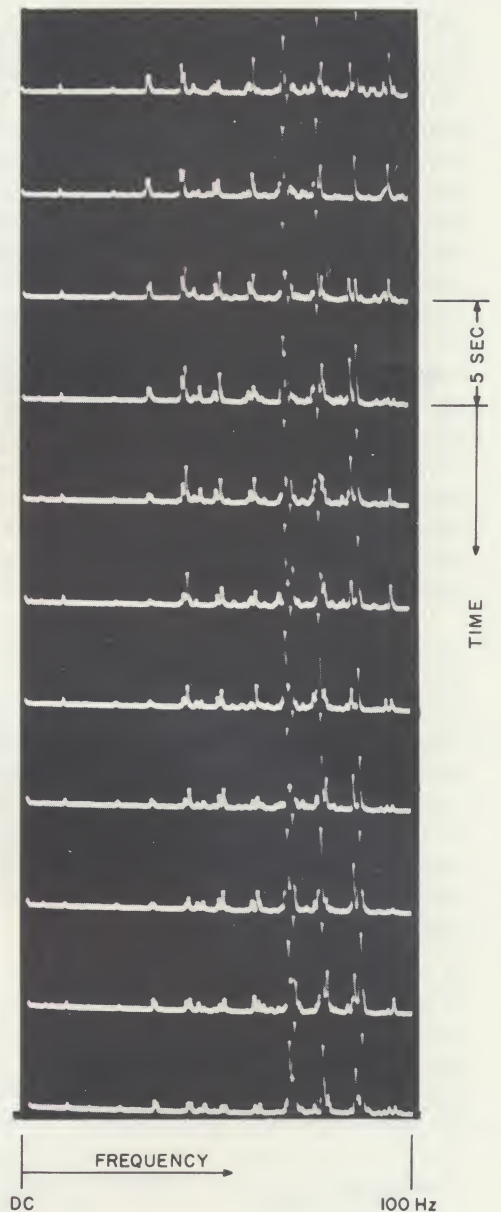
Chronological spectrograms of heart sounds in patient with patent *ductus arteriosus*. The frequency resolution is 20 Hz, and the time between successive spectrograms is 50 milliseconds.





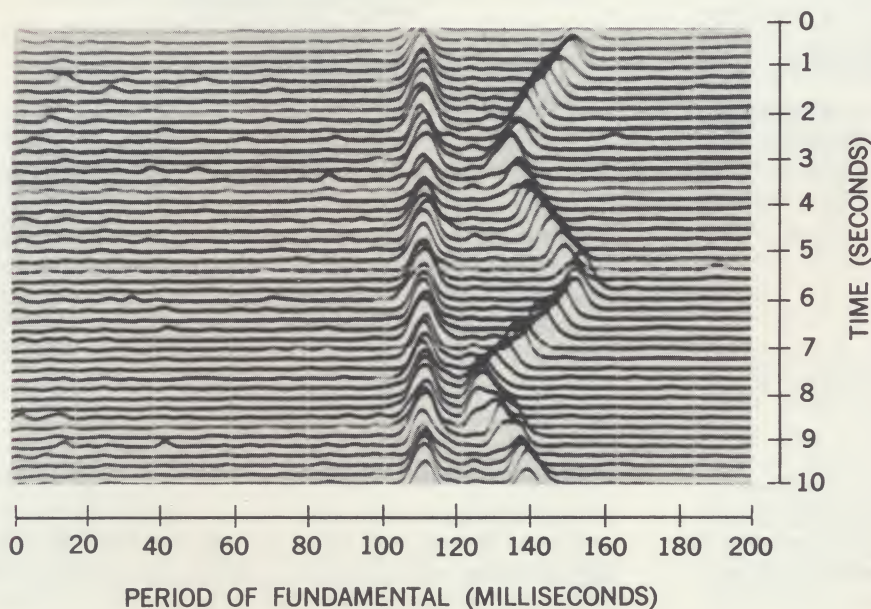
Amplitude and intensity-modulated displays of chronological spectrograms of machinery vibration. The time between successive spectrograms is 5 seconds, and the total time spanned by the sequence of spectrograms is 50 seconds. The frequency resolution is 0.2 Hz.

SPECTRAL AMPLITUDE



Iterated spectrum analysis ("cepstrum") of two pulse trains in noise. The conventional spectrum analysis of the pulse trains is first obtained, exhibiting the two fundamental frequencies and their harmonics. The Ubiquitous® Analyzer output maps frequency linearly into the time domain, permitting the spectrum to be reinterpreted as a new time function. The harmonic nature of the original pulse train spectra causes periodicities in the new time function, which a

second spectrum analysis extracts. In the second spectrum analysis, the power of all the pulse train harmonics is accumulated constructively to identify the repetition period of the two signals, without mutual interference and despite the poor original signal-to-noise ratio. One signal has a steady repetition period of 110 msec, while the other period fluctuates between 125 and 155 msec. The analysis shown required 10 seconds in real time.



DESCRIPTION OF THE UBIQUITOUS® SPECTRUM ANALYZER

Ubiquitous® Spectrum Analyzers perform real-time Fourier analysis at all frequencies simultaneously, within the selected analysis band. The voltage or power spectral density is obtained for continuous signals, intermittent signals, and one-shot transients. The name "Ubiquitous®" denotes the ability of this instrument simultaneously to observe each and every frequency component continuously (with 100 percent duty cycle), and to present the Fourier analysis of all frequencies in real time. This ability is extremely useful when one desires to observe the complete spectrum of a dynamic process in real time, or when the quantity of Fourier analyses required renders other techniques too cumbersome and costly.

The simultaneous equivalent of thousands of contiguous bandpass filters are synthesized by the Ubiquitous® Spectrum Analyzer within a single signal path; as a result the synthesized resolution elements possess a stability and uniformity that are unattainable by other techniques. The use of exclusively solid-state circuitry, with the majority of circuits integrated, results in extreme reliability, small size, and low power consumption.

An internal memory can capture "snapshots" of one-shot transients or desired portions of continuous or intermittent signals. The signal in storage is Fourier-analyzed, and also presented in the time domain at an output terminal for examination on a convenient time base in parallel with the spectrum presentation. This capability can supplant tape loops, storage oscilloscopes, and the like. The coordinated time-domain and frequency-domain displays are of great advantage in many applications, and can be used both continuously and with transient signals.

A broad selection of spectrum analysis characteristics is available in the Ubiquitous® Analyzer. Five ranges of analysis parameters typically are obtained by a front panel switch (additional ranges are optional). The characteristics of the five typical ranges are listed in Table I below.

TABLE I
TYPICAL ANALYSIS RANGES AND BANDWIDTHS

Range	Analysis Range (Hz)	Bandwidth of Synthesized Filters, β (Hz)
A	0 to 10,000	20
B	0 to 5,000	10
C	0 to 1,000	2
D	0 to 500	1
E	0 to 100	0.2

Definitions of Terms

Width of analysis range — the width of the interval in the frequency domain which is Fourier-analyzed simultaneously.

Bandwidth of synthesized filters — the nominal resolution bandwidth. This value, which is the reciprocal of the time duration of the input signal contributing to the spectrum analyzer output, determines the noise bandwidth in a system in which the Ubiquitous® Analyzer serves as the final signal resolution stage.

Spectrum Display Periods

Spectrum display periods of 0.05 seconds, 0.5 seconds, 5 seconds, and 50 seconds are selectable with a front-panel control. The spectrum-display period is the time required for the display of one complete spectrum analysis covering the full width of the selected analysis range.

The shortest display period provides a flickerless oscilloscope presentation with 20 analyses per second. The longer display periods permit direct recording of the spectrum analysis on mechanical recorders and plotters.

Any display period can be employed with any Analysis Range. In order to keep up with the possible fluctuation of the spectrum of a dynamic signal, it is necessary to choose a spectrum display period which does not exceed the reciprocal of the filter bandwidth selected. However, if the signal is a one-shot transient or a segment of a continuing signal, it can be captured in real time by the internal memory and displayed in the frequency domain at any selected rate.

Provision is made for the spectrum scan to be either free-running or synchronized. A linear sweep voltage is provided at an output terminal which can be used for the frequency axis of oscilloscopes and recorders. Trigger pulses to synchronize displays of the spectrum and the time-domain signal presentations are provided at trigger output terminals.

Number of Filters Synthesized

The number of equal-bandwidth synthesized filters of completely uniform frequency characteristics covering the analysis range varies between 500 and 500,000, depending on the spectrum display period selected. The relation between the spectrum display period, the number of filters synthesized, and the filter spacing is given as follows:

TABLE II
DISPLAY PERIOD, NUMBER OF FILTERS SYNTHESIZED
AND FILTER SPACING

Display Period seconds	Number of Filters Synthesized	Filter Spacing
0.05	500	1 bandwidth
0.5	5,000	0.1 bandwidth
5	50,000	0.01 bandwidth
50	500,000	0.001 bandwidth

The selection of a spectrum display period associated with the synthesis of 5,000 filters or more results in a quantization of the frequency axis so fine that the obtainable frequency resolution practically reaches the theoretical limit imposed by the signal-to-noise ratio and the bandwidth of the synthesized frequency-resolution elements.

Time-Domain Display

The waveform in storage in the digital memory is available in analog form at an output terminal. Regardless of the rate at which the signal was supplied to the Ubiquitous® Analyzer, the entire contents of the

memory can be displayed with a repetition period of 100 usec.

Transient Capture Mode (replaces tape loops and storage oscilloscopes)

The internal digital memory can be made fully retentive for the purpose of obtaining and analyzing "snapshots" of one-shot transients or selected segments of continuous signals. The retained waveform is available in analog form for repeated display in the time domain while its spectrum is analyzed.

Principle of Operation

Ubiquitous® Analyzers perform storage and speed-up of the input signal to enable an extremely stable, precisely designed crystal filter to examine a very broad input spectrum rapidly.

The input signal is first attenuated and band limited by the filter on the range selected. Then this limited input signal is fed to a high-quality analog-to-digital converter which converts it to digital form. The rate at which the signal is sampled is set conservatively in excess of sampling-theorem requirements in order to guarantee faithful extraction of the spectrum. The digitized samples are passed in parallel binary form to a digital memory. The sample values progress through successive positions in the memory at a rate which is very rapid compared to the input sampling rate. The digitized samples emerging from the memory output are fed back into the memory input and are sequenced with respect to newly obtained input samples so that the memory contains all the samples in the same order as they arrived originally in real time.

The time interval between consecutive samples taken from the input signal is extremely long compared to the interval between the emergence of successive samples from the memory. This situation results in a great contraction of the signal time base, or, equivalently, a dilation of the signal's frequency spectrum. This operation

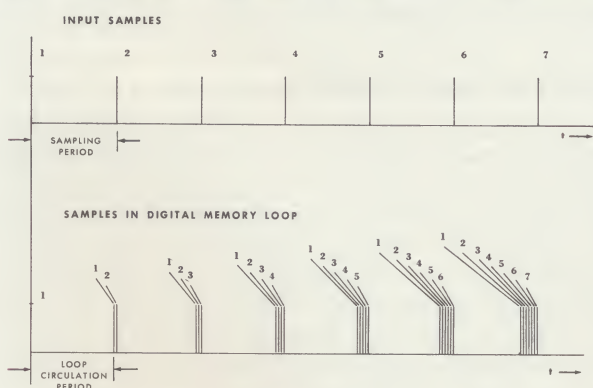


Fig. 1 Timing Diagram Illustrating the Sample and Speed-up Technique

is illustrated in Figs. 1 and 2. It is thus made possible for a wide-bandwidth filter to examine the dilated spectrum with the same net frequency resolution as a narrow-bandwidth filter operating on the unaccelerated input signal. However, the settling time of a wide-

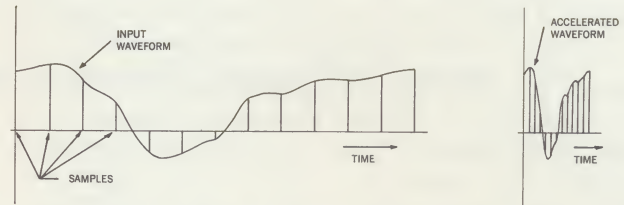


Fig. 2 Waveform Acceleration

bandwidth filter is very short, so that it can be moved rapidly through the dilated signal spectrum. The speed-up factor is chosen to permit the entire spectrum to be analyzed by one broad bandwidth filter in the time that would have been required to examine a single resolution element with the same equivalent resolution at the input. A real-time simultaneous analysis is thereby obtained.

The mathematical consequence of compressing the signal's time base in this manner can be demonstrated by examining the effect it produces on the signal's Fourier integral, or spectrum. Let the input signal be $s(t)$, and let its Fourier transform be $S(f)$.

$$S(f) = \int_{-\infty}^{\infty} s(t) \exp \{-j2\pi ft\} dt$$

Let the temporal speed-up factor be k . Then the accelerated signal can be written as $s(kt)$. The Fourier transform of the accelerated signal is:

$$\begin{aligned} \mathcal{F}\{s(kt)\} &= \int_{-\infty}^{\infty} s(kt) \exp \{-j2\pi ft\} dt \\ &= \frac{1}{k} \int_{-\infty}^{\infty} s(kt) \exp \left\{-j2\pi \frac{f}{k} tk\right\} dk \\ &= \frac{1}{k} S\left(\frac{f}{k}\right) \end{aligned}$$

It is evident that the accelerated signal possesses a spectrum $S(f/k)$ of precisely the same form as $S(f)$, but with corresponding frequency components separated k times as much.

The digital memory output is fed to a digital-to-analog converter. The output of this converter is the accelerated replica of the original input signal. It is applied to the stable crystal filter via a heterodyner which causes the crystal filter to observe successive frequency-resolution cells in sequence. The settling time of the crystal filter is short enough to permit it to make a completely fresh observation each time the digital memory undergoes one recirculation. The output of the digital-to-analog converter is also supplied to a front-panel output terminal to allow continuous observation of the signal circulating in the memory.

Fig. 3. The signal is fed to a front-panel attenuator possessing a 60-db range with 6-db calibrations. A level meter permits the attenuator to be set so that the signal optimally occupies the dynamic range of the subsequent digital circuitry.

BLOCK DIAGRAM DESCRIPTION OF THE UBIQUITOUS® SPECTRUM ANALYZER

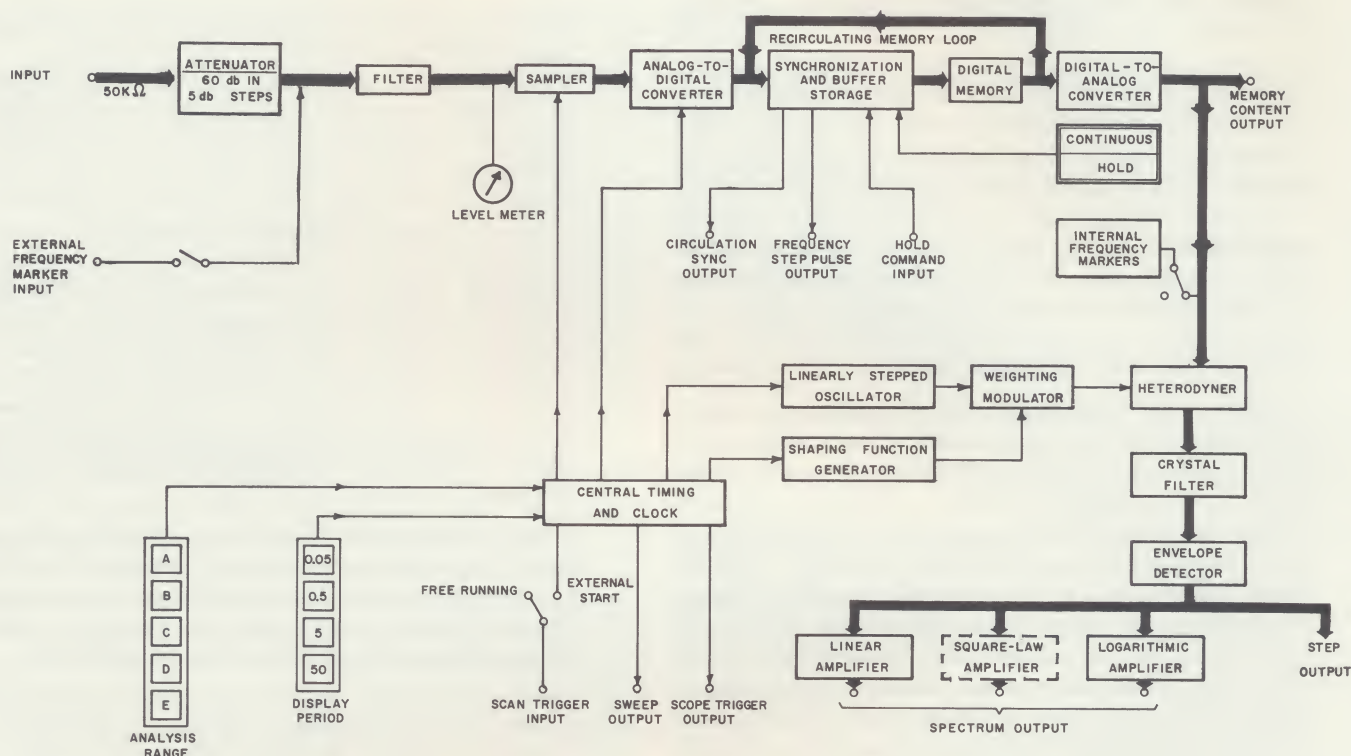


Fig. 3 Block Diagram of the Ubiquitous Spectrum Analyzer

The attenuated input signal is applied to a sampling circuit through a low-pass filter. This filter restricts the signal spectrum to a value equal to the frequency-coverage width of the analysis range chosen as listed in Table I. This restriction is necessary to ensure that sampling will not cause spectral distortion of any kind. The sampling rate is set safely in excess of the value required by the sampling theorem in order to guarantee complete fidelity (If the input signal is not originally located at the low end of the spectrum, it is necessary to translate it to the low end before sampling; this is accomplished in the optional mixer when the switch is in the *Band Pass* position, and permits the frequency interval under analysis to lie anywhere between near zero and 1 MHz. A filter in the balanced mixer restricts the spectral width of the signal to the value equal to the coverage width of the analysis range chosen.)

The samples are fed to an analog-to-digital converter. In the standard model, the converter produces 9-bit binary words. Extreme linearity is maintained in the analog-to-digital conversion; no amplitude compression, saturation, or other non-linearities are allowed, since they could result in intermodulation between signal components leading to the generation of spurious components or the extinction of weak frequency components.

The digitized samples are placed in a buffer storage before being fed to the recirculating digital memory. The timing is arranged so that successive samples are placed in the memory in the same order in which they

originally arrived at the input to the spectrum analyzer, but the time between consecutive samples in the memory is extremely small compared to the inter-sample period of the original waveform. The output of the recirculating digital memory loop is converted to analog form by the digital-to-analog converter. The converter output is supplied to the *Memory Content Output* terminal on the rear panel to permit continuous observation of the signal in the memory. The analog waveform from the converter is also fed to the heterodyner for frequency analysis by the crystal filter.

The Transient Capture Mode

In the usual mode of continuous operation, the Synchronization and Buffer Storage unit discards the oldest sample in storage when the memory is completely full and places the newest incoming sample in its place. This continually refreshes and updates the memory, producing the same replenishment that occurs with a conventional finite-memory filter. However, the user may prefer to capture a one-shot transient, or an especially interesting segment of a continuing signal, in the memory. This can be accomplished by inhibiting the sample replacement function of the Synchronization unit. When this is done, the memory contents will be retained indefinitely in recirculating storage, and may be viewed in the time domain at the *Memory Content Output* terminal while the spectrum is analyzed at leisure.

The Transient Capture Mode can be initiated in

either of two ways. The first is by pushing the *Hold* button on the front panel. This causes the signal in the memory at that instant to be retained. The length of the retained signal depends on the *Analysis Range* selected, and is tabulated below. A light goes on in *Hold*, indicating that the memory has been placed in the retentive condition. In order to release *Hold*, the *Continuous* button is pushed. This immediately restores the memory to the continuous replenishment mode, and the *Continuous* button light is illuminated.

The second means of initiating the Transient Capture Mode is to supply a pulse to the *Hold Command Input* terminal. The memory will retain the signal in the memory at that instant. The temporal length of the signal which the memory can retain depends on the *Analysis Range* selected, and is tabulated below. The *Hold Command* pulse lights the *Hold* button light. This indicates that the signal in storage will be recirculated indefinitely. The *Hold* condition can be terminated by pushing the *Continuous* button or by applying a *Hold Release* signal to the *Hold Release Input*. In either case the memory is immediately restored to the continuous replenishment mode, the light in the *Hold* button goes off, and the light in the *Continuous* button goes on.

TABLE III
LENGTH OF INPUT SIGNAL IN MEMORY

Analysis Range	Signal Length	Width of Analysis Range
	seconds	Hz
A	0.05	10,000
B	0.1	5,000
C	0.5	1,000
D	1.0	500
E	5.0	100

Output

The output of the digital-to-analog converter is applied to the heterodyner where it is mixed with a sinusoid whose frequency is carefully stepped. The steps occur in synchronism with the recirculations in the digital memory. A new frequency component of the signal is heterodyned into the pass band of the crystal filter at each recirculation. The crystal filter thereby analyzes the entire spectrum of the signal by responding successively to adjacent frequency components. The dilation of the signal spectrum permits the settling time of the crystal filter to be very rapid, and so the entire spectrum can be examined in a short time. However, it may sometimes be desirable to record the spectrum on an X-Y plotter, or other mechanically deflected device, whose limited response rate does not permit it to follow the most rapid analysis rates of the Ubiquitous® Spectrum Analyzer. In order to accommodate this possibility, a selection of spectrum display periods is provided by controlling the time taken by the Linearly Stepped Oscillator to move from one end of its frequency range to the other. This is accomplished by decreasing the size of the frequency steps, while keeping the dwell time at each step fixed and equal to the memory recirculation period. As the frequency increment between steps decreases, the number of resolution elements synthesized increases correspondingly. The relation be-

tween the spectrum display period, the frequency interval between resolution cells, and the number of equivalent filters synthesized is listed in Table II. (p. 4).

While 500 synthesized filters spaced one bandwidth apart permit an extremely good view of the spectrum, 5,000 synthesized filters spaced 0.1 bandwidth apart are practically equivalent to a continuum of resolution cells. Beyond this number of synthesized filters, almost no further advantage is gained because of the high degree of redundancy of overlapping resolution cells. However, long display periods with their slower output fluctuation rate permit the use of slow-response recorders.

Any display period may be employed with any analysis range. It should be noted, however, that, in order to take full advantage of the real-time analysis capability of the Ubiquitous® Spectrum Analyzer, it is necessary to examine the entire spectrum often enough to observe the fluctuations of the output of each resolution cell. The time required for the output of a synthesized filter to fluctuate substantially is equal to the reciprocal of the filter's bandwidth. This assumes that the input signal is non-repetitive and possesses a spectrum that fluctuates at the fastest rate the analysis resolution will permit; if the input signal is repetitive, its spectrum will not fluctuate, and the outputs of the synthesized filters will not change.

The output of the crystal filter is linearly envelope-detected and fed to linear and logarithmic amplifiers. The linear amplifier output gives the absolute value of the voltage spectral-density function. The logarithmic amplifier gives the same result, but with logarithmic compression (equivalent to using a db scale) in order to make the small frequency components more visible. A square-law amplifier can also be provided, as a special option, whose output gives the power spectral density of the signal in the memory.

A pulse is supplied at the *Frequency Step Pulse Output* terminal to denote the advance from each frequency resolution element to the next. A pulse is supplied at the *Scope Trigger Output* terminal to indicate the beginning of the spectrum presentation at the low frequency end of the frequency axis. A linear deflection waveform in synchronism with the frequency sweep is supplied at the *Sweep Output* terminal for use in providing the sweep voltage for displays which do not possess their own sweep generators. If it is desired to control the instant at which the frequency spectrum examination starts from the low frequency end, the *Free Running-External Start* switch should be placed in the *External Start* position and a pulse supplied at the desired instant to the *Scan Trigger Input* terminal.

Frequency Characteristic

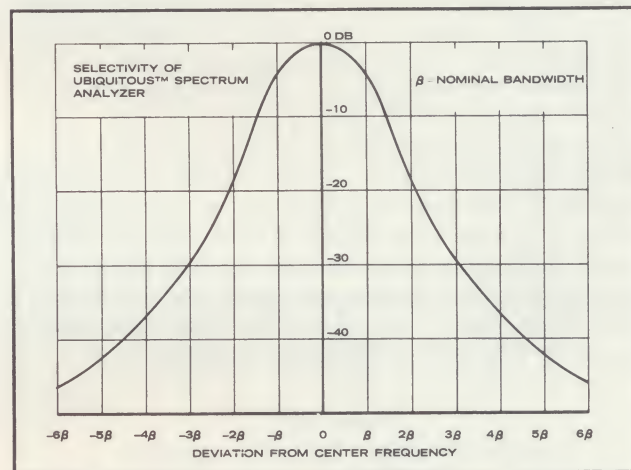
The frequency selectivity characteristic of each synthesized resolution element is produced in the Ubiquitous® Spectrum Analyzer through a technique which overcomes the usual restraints between the frequency selectivity of a filter and its transient response. A fixed parameter filter cannot simultaneously provide fine resolution in the frequency domain and rapid

transient response in the time domain. As a result, a compromise between frequency selectivity and transient response is necessary, with the Gaussian characteristic often chosen as the most palatable allocation of dissatisfaction. The limitations of fixed-parameter filters are overcome in the Ubiquitous[®] Spectrum Analyzer by taking advantage of the fact that the instants at which each circulation of the signal in storage begin and end are known precisely. This permits the parameters of the analyzing filter to be time-varied in synchronism with the passage of the signal around the recirculation loop, with a resulting substantial superiority over the characteristics achievable with fixed-parameter networks.

During each signal passage around the loop, the Shaping Function Generator provides an output to the Weighting Modulator which imposes the shaping function as amplitude modulation on the Linearly Stepped Oscillator input to the Heterodyner. The Heterodyner is a square-law stage operated well within the square-law portion of its characteristic, so that its output is proportional to the product of its two inputs; as a result, the signal arriving at the Crystal Filter is the output of the Digital-to-Analog Converter multiplied by the shaping function. The effect on the Crystal Filter output is the same as modifying the impulsive response of the Crystal Filter to include the shaping function. Through the choice of an appropriate shaping function, the frequency selectivity characteristic of a complex network can be produced while retaining the simple structure and rapid discharge characteristic of a singly-resonant

filter. An additional advantage is that the frequency characteristic can be modified readily by changing the shaping function.

The frequency-selectivity characteristic supplied in the standard model Ubiquitous[®] Spectrum Analyzer is shown in Fig. 4. It has an asymptotic skirt slope of 18 db per octave. The parameter β is the bandwidth listed for each Analysis Range in Table I. Other frequency characteristics can be supplied upon request.



Typical Frequency Selectivity of the Ubiquitous[®] Spectrum Analyzer — Standard Model

Photograph of the Ubiquitous Spectrum Analyzer with Cover Removed



UBIQUITOUS® SPECTRUM ANALYZER OPTIONS AND ACCESSORIES

The versatility of the Ubiquitous® Spectrum Analyzer is extended by the availability of various optional features and accessories to accommodate the requirements of special applications. The following list contains items which are currently available. New options and accessories will be added in response to new requirements. Your inquiries are solicited concerning features which do not appear in the list.

Option

No.	Input Options	Packaging Options
11	93-ohm input impedance	61 Built-in fixed locations of Analysis Ranges (as specified by customer) with internal oscillator steps
12	75-ohm input impedance	*61x Origin step oscillator (external unit)
13	50-ohm input impedance	62 Relay control of Analysis Range switches
**14	External sampling control	63 Relay control of Display Period switches
*14ax	Spectrum order normalization	**64 Rear terminals in parallel with front-panel terminals
16	Non-standard attenuator steps	65 Rear terminals instead of front-panel terminals
18	Digital output from input a-d converter	
19	Analog monitor of input to a-d converter	
	Analysis Options	
21	60-dB dynamic range	
28	Variable Beta (previously UA-60 feature)	
30	Built-in non-standard Analysis Ranges (low pass or bandpass)	
*30x	Range translation unit (external unit)	
33	Customer-specified selectivity characteristic	
37	Shock spectrum analysis	
	Output Options	
**41	Square-law spectrum output (power spectral density function)	
51	Direct digital input	
52	Built-in digitized spectrum amplitude	
*52x	Digitized spectrum amplitude. (external unit)	
	(Note: Options 14 and 28 or 28 and 30 (Bandpass) do not operate together)	
	*UA-6 accepts these options only	
	**Standard on the UA-6	
		Packaging Options
		81 Militarized - to meet military environment and performance specifications on special order
		*83 Slides attached for pull-out rack mounting
		*84 Cabinet
		Miscellaneous Options
		91 Special paint
		*92a Operation from 50 Hz line frequency
		*92b Operation from 220 VAC nominal line voltage (on special order)
		Output Accessories
		128 35mm continuous-motion movie camera and adaptor
		129B Single Channel Digital Averager
		*129H High-resolution digital spectrum averager (with various Mods)
		160 Intensity modulation interface (for Honeywell 1806 direct writing real time recorder)